SCIENCE

VOL. 94 FRIDAY, SEPTEMBER 19, 1941 No. 2438

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SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

Lancaster, Pa. Garrison, N. Y.

New York City: Grand Central Terminal

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary in the Smithsonian Institution Building, Washington, D. C.

SUCCESSES AND FAILURES OF EXPERIMENTAL PSYCHOLOGY[1]

By Professor R. S. WOODWORTH

COLUMBIA UNIVERSITY

IT is customary to claim for psychology that, while it has a long history as a branch of philosophy, it can be excused for a considerable degree of immaturity because of its youth as a branch of experimental science. As the decades go by this excuse becomes less and less convincing. There are several very active and successful sciences, as physical chemistry and bacteriology, which are really younger than experimental psychology. If these sciences have made more rapid progress than psychology, the reason may be that they are working with phenomena that lie further from everyday experience, so that their discoveries are more striking. Other reasons can be suggested. Possibly psychology has undertaken a harder job, a more complicated problem to unravel—or possibly psychologists have not been making good use of their time. At any rate psychology should be able by now to point to substantial achievements won by use of experimental methods, along probably with a number of failures which may be quite instructive in themselves. It would be too much to attempt here and now to answer the question, how much has been achieved by experimental psychology in the half century or more of its existence. We can only touch a few high (and low) spots in the hope of conveying some idea of the progress of psychology as it appears to those who are actively interested in pushing it forward.

[1] Annual Sigma Xi address, Indiana University, March 13, 1941.

BEGINNINGS OF EXPERIMENTAL PSYCHOLOGY

No precise date can be assigned for the beginnings of our science. The year 1860 is as suitable as any. Before that time, and during all the earlier part of the nineteenth century, physicists and physiologists had been occasionally making experiments which could properly be included in psychology. There were many experiments on the senses and sense perception. Just about 1860, Helmholtz and Fechner organized these earlier results and suggested laboratory methods for the further study of such problems. Almost simultaneously Darwin gave a start toward the scientific interest in animal behavior and child development, matters which have become very important to the psychologist. Darwin was soon followed by Francis Galton, who ranks as one of our pioneers for his work on individual differences, tests and correlations. In Germany, Helmholtz and Fechner were followed by Wundt and other leaders who established psychological laboratories in some of the universities, beginning about 1880. These laboratories were adjuncts of the departments of philosophy, and their first directors were professors of philosophy. This was generally true as the new movement spread to other countries, though in a few universities the psychological laboratory was at first attached to the laboratory of physiology. In general the physiologists were fully occupied with other developments in their rapidly growing science.

The American universities were prompt to adopt the new psychology. In the eighties and nineties a large number of laboratories were established from the Atlantic to the Pacific. The Indiana laboratory was one of the first. Except for scattered studies the birth of experimental psychology was nearer 1890 than 1860. Just about now many of our laboratories are celebrating their fiftieth anniversaries, and the American Psychological Association, organized by the young protagonists of the new movement, is to have its jubilee in 1942.

The motive animating these pioneers was partly the desire to see psychology emulate the older sciences and partly a sense of the futility of endless discussion unsupported by definite data. As Wundt said in 1862, psychology was properly a natural science but had made little progress since Aristotle. Its stagnation was due to its lack of scientific methods and to the metaphysical problems in which it was enmeshed. If psychology would turn its attention to questions answerable by natural science methods it would be on the road to progress.

We can not complain of the attitude of the philosophers. Without some support from them, those laboratories could not have appeared in such rapid succession. The philosophers were indeed rather sceptical as to the scope of experimental psychology. It could perhaps shed some useful light on minor questions but could scarcely be expected to solve the great problems of body and mind and the theory of knowledge. Probably they were right, and probably Wundt was right as well in holding that psychology should turn its attention to new problems. Psychology had to explore and find its own distinctive problems as it became acquainted with its proper field.

Scepticism was not confined to the philosophers. Many natural scientists believed the field of mental phenomena and operations much too intangible and elusive for genuine experimentation. "How can you possibly experiment on the mind?" was a common query. "You can not control your variables." Some work could be done on the senses, but such work was more appropriate for physiology than for a science of the soul or mind. True enough, anything like a mystical or transcendental conception of the mind rules out or scares away the experimental psychologist. But he has found other ways of conceiving the mental activities of the individual. Though there is some real difficulty in controlling the variables the project is not so hopeless as it seemed at first. The attempt must be made, anyway, unless we are willing to resign ourselves to continued ignorance.

The psychologists went to work in their new laboratories. There was much work still to do on the senses, and here the physiologists and physicists have continued their efforts, the psychologists however contributing a respectable share toward the progress that has been made. There have been failures as well as successes, but we will pass on to other problems that are perhaps more characteristic of psychology.

PSYCHOPHYSICS

Fechner, as much as any one, is entitled to be called the father, or grandfather, of experimental psychology. Primarily a physicist, he was also a philosopher of a rather mystical turn who believed in the existence of two worlds, the physical and the psychical. What he called psychophysics was an attempt to demonstrate definite relations between the two worlds. When light stimulates the eye or sound the ear the stimulus belongs in the physical world, the sensation in the psychical world. Living at a time when the conservation of energy was a new discovery and when the transformation of energy from one physical form to another was being investigated, Fechner asked whether some equation could not be worked out between the energy of the stimulus and the intensity of the sensation. As the stimulus increases the sensation increases but seemingly not so fast. Weber's law, which Fechner named after its discoverer and further tested out and verified to a reasonable extent, was interpreted

by Fechner as showing that the sensation increases as the logarithm of the stimulus intensity. So he had a psychophysical law. The experiment was a success in his own view.

But Fechner did not succeed in convincing the scientific world that his law was truly psychophysical. It seemed more likely to be purely physiological. For proving his point to his contemporaries or successors, his experiment was a distinct failure. Nevertheless as an empirical law, subject indeed to certain limitations, the Weber-Fechner finding has proved of considerable importance, both in science and in engineering. And the psychologists are deeply grateful to Fechner for the skill and care with which he worked out experimental methods for testing his law. These methods have proved to be invaluable in a variety of problems.

The Reaction Time Experiment

One of the oldest psychological experiments can be seen in operation on the athletic field. The contestants in a foot race line up, are told to be ready, and then get the signal to go. If the time from this signal to the first forward movement of the runner were measured, it would differ from one individual to another and probably average about one fifth of a second. Take this performance into the laboratory and simplify the conditions, substituting a finger movement for the forward spring of the whole body, and you have the reaction time experiment. What scientific use can be made of so simple a thing?

The experiment was first used by Helmholtz in 1850 in the hope that it would furnish a measure of the speed of conduction in the sensory nerves of man. He had succeeded in measuring the speed in the motor nerves of an animal. He could tell when the nerve current reached a muscle by the resulting muscle twitch, but he had no way of telling exactly when a sensory nerve current reached the brain. The best he could do was to instruct his human subjects to react with the hand as soon as they felt a weak electric shock applied to some part of the skin. The farther this part of the skin was from the brain, the longer the sensory nerve conducting to the brain and the more time should be required for the whole reaction. The experiment was only moderately successful, there was so much variation in the reaction time, due doubtless to variation in the brain process involved. At least, the variability of the brain action in so simple a performance is a fact worth knowing.

Another use was soon suggested for this experiment. Complicate the performance and see how much additional time is required. Instead of a single, uniform stimulus to which the subject always makes the same reaction, let him understand that there are to be two stimuli, a red and a green light, and that when the red appears he is to move his right hand; when the green, his left hand. It takes him about one tenth of a second longer. The brain has an additional task to perform—or two additional tasks, that of distinguishing between red and green, and that of choosing the correct hand for the reaction. Therefore, it was inferred, the extra one tenth of a second is the time required by the brain for the acts of discrimination and choice.

The hope of certain experimenters, back in the sixties, seventies and eighties, was by use of this experiment to determine the time required for each elementary mental operation, like discrimination, choice, recognition, association. The idea was to insert extra elements of performance into the reaction and to see how much extra time was required for each element. The plan broke down because the subject did not passively wait for the stimulus and then go through the supposed sequence of elementary acts. Instead, he was active before the stimulus arrived, preparing himself for the total act he had to perform. When the act was completely defined in advance, as in the simple reaction, the subject's preparation was very definite, but when two possibilities were in prospect, he could not prepare himself so completely. His reaction was slower because his preparation was less complete, and the extra time required was not merely the time of an inserted elementary act.

Obviously, the reaction time experiment was a failure, so far as the original purposes of the experimenters were concerned. Yet the results were instructive in a number of ways. They showed the importance of what we now call "preparatory set," the state of readiness for an anticipated reaction. And reaction time has proved to be a useful tool in investigating various problems. When Cattell, working in Wundt's laboratory about 1885, found by the reaction time method that familiar short words were perceived and read as quickly as single letters, the result threw much light on the psychology of perception and on the best method of teaching a child to read.

Experiments on Learning, Memory and Motor Skill

The early psychological experimenters saw no way of attacking the "higher mental processes," but in the eighties Galton in England and Ebbinghaus in Germany showed that memory and related processes could be brought into the laboratory. It was Ebbinghaus who invented nonsense syllables for use in memory experiments. He presented a series of such totally unrelated items for the learner to connect and memorize. Entirely new connections had to be established, as would not be the case with a sequence of

familiar words. By this device Ebbinghaus succeeded to a certain extent in controlling an otherwise disturbing variable. He obtained a characteristic "curve of forgetting," showing that the loss of barely learned material is rapid at first and slower as time goes on. He varied the conditions of learning and demonstrated the operation of a number of significant factors. His work put new life into the laboratory and started a line of investigation which continues fruitfully down to the present, with many ramifications. On the whole his experiment was a decided success.

On one respect, however, the original experiment of Ebbinghaus must be called a failure. He apparently assumed the learning process to consist in an automatic establishment of associations between the nonsense syllables. The learner was giving careful attention to the material, to be sure, but the connections were supposed to be formed by a simple mechanical process and strengthened by a mere repetition of this process. Later experimenters, by varying the method and obtaining more complete data, have found that the learning process is by no means simple and automatic. The learner is intensely active, grouping the syllables, noting their positions and their similarities and differences, and often reading some meaning into the syllables. The first experiments had left a false impression of the nature of the learning process. Objection has also been raised to the use of nonsense syllables because of their artificiality, but this objection is not very serious because in the first place the method is easily extended so as to employ meaningful material, and in the second place, no matter how artificial the material, the learner is not made artificial, and the various ways in which he attacks the artificial task bring out very clearly the characteristics of an intelligent learner.

An important next step in the experimental psychology of learning was taken here at Indiana University in the nineties, when Bryan and Harter conducted their pioneer experiments on the acquisition of skill. The telegrapher's skill was the particular topic of their investigation, which was followed up in the next decade by Book's study of the process of learning to use the typewriter. These experiments can be counted among the eminently successful ones and they inaugurated another long series of investigations, by many experimenters in various places, dealing with the problem of how motor skill is acquired.

In learning to typewrite, for example, one must first become familiar with the keyboard so as to strike each letter promptly and accurately as it is reached in spelling out a word. When the learner can do this he assumes he has mastered the art, in principle, and needs only to increase his speed. As he continues he is surprised to find himself performing in unexpected ways. He catches himself in the act of writing a familiar word without spelling it out. His fingers go through the necessary sequence of movements as an integrated pattern, no longer as a series of discrete acts. These spatial-motor patterns are called "higher units." The telegrapher also, after considerable practice, hears a whole sequence of clicks from the sounder as an auditory pattern. He hears word units rather than letter units or single clicks. Higher units are built up in any skilled performance. Some of the best examples are found in ordinary speech. To speak a word demands a sequence of speech movements—one for *c*, one for *a* and one for *t*, in pronounced the word *cat*—and the little child learns by degrees to build up this unit. It becomes so much a unit that later he can scarcely break it up into its parts. He hears it as a unit, too.

Within the general field of experiments on learning the next development was the study of problem-solving and learning in animals. Here again the work began in the nineties. The original interest was in the evolution of animal intelligence, but a more definitely psychological problem soon came into view. The learning process seemed to be fundamentally the same in man and the higher animals, and the fundamentals were more clearly revealed in the simpler behavior of animals than in man with his intellectual and linguistic devices for rapid learning. On the whole these animal experiments must be counted among the successes of psychology, though it would not be difficult to find particular studies that have started with false assumptions and led temporarily to false conclusions.

About 1900 a new type of experiment on learning was originated in Russia by the physiologist, Pavlov. This was the conditioned reflex experiment. A dog's saliva will start to flow, not only when food is placed in his mouth (a natural reflex) but also when a bell is rung, provided the bell has repeatedly been rung just before he receives his food in a familiar laboratory situation. Evidently this conditioned reflex is a learned response. It was so regarded by Pavlov, but he was not particularly interested in it from this angle. To him it was an indicator of the physiological processes of excitation and inhibition going on in the brain. He insisted that his experiment was definitely physiological and not in the least psychological. Nevertheless the psychologists appropriated the experiment as a new lead in the study of learning. It might go to the bottom of things and provide an explanation of all forms of learning. They have tried the experiment on human as well as animal subjects and have varied it in many ways. The more recent experimenters find, however, that conditioning is by no means so simple a process as was first supposed. It is not a mere attachment of an old response to a new stimulus

but is, rather, the building up of a new pattern of response adjusted to a particular combination of stimuli. It depends on good adjustment to the total situation. And the process of becoming conditioned sometimes involves trial and error and even insight. In short, though the external conditions are greatly simplified as compared with ordinary life, the subject himself is not simplified but is free to utilize any of his devices for meeting a novel situation.

THINKING

After a start had been made in experiments on learning and memory, the next question was whether any feasible experiment could be contrived for studying the thought processes. Some information on problem solution by men and animals could be obtained from the learning experiments, since the subject's first trial in a new task calls for the solution of a novel problem. What is usually called the "thought experiment" dates from early in the present century. The subject is assigned a problem to solve and reports what he can of his procedure. Time is taken and other objective records may be made of his behavior. This rather rudimentary experiment has yielded some interesting results but can not be called an outstanding success. At first interest was centered on the question, what mental images were used in thinking. Some subjects reported visual pictures "before the mind's eye," other subjects reported mostly inner speech, others reported that when a new idea was just dawning on them it came neither in words nor in pictures but just as a bit of meaning, an "imageless thought." The results were rather intangible and the whole enterprise languished after a few years of great activity. One definite finding was that the "set" for the task, which had been found important in reaction time experiments, was a potent factor also in thinking and intellectual work. The thinker adjusts himself to his task and so steers his thoughts more or less definitely in the right direction.

A little later the behaviorists suggested that thought was probably a motor activity. It might consist largely of slight movements of the speech organs. At first the child thinks aloud, we may suppose, and later cuts down the amplitude of his speech movements while still thinking with his mouth and larynx, though perhaps also with his hands and feet. This theory challenged the experimentalist to detect any slight speech movements that might occur during silent thought. Hopefully he applied recording instruments to the tongue and to the neck over the larynx, and he obtained evidence of some muscular activity during thought but nothing that seemed characteristic of different thoughts. His instrumentation in this first period was crude and lacking in sensitivity. Nowadays amplified muscle potentials afford a much better index of slight motor activity, and this method does show some muscular activity in the arm, for example, when the subject thinks of lifting a weight. This line of investigation is still in its early stages and we can not predict how much it may show regarding the dynamics of the thought process.

MOTIVES AND EMOTIONS

An important problem under the head of emotion can be put as follows: What is the state of the organism in fear, rage, joy and the various emotions? We have a partial answer from physiological and psychological experiments. As to the motivation of behavior we have some rather fundamental findings from the animal laboratory. This whole line of work is difficult and has scarcely made satisfactory progress.

Mental abnormalities, the neuroses and psychoses, are due to emotional disturbance and conflict of motives more than to intellectual disorder. So the psychiatrists believe, but they say they can find little of value in the experiments of psychologists on motives and emotions. Freud in particular denied that he could get anything at all from the experimental psychologist, but he may not have tried very hard. He was himself in a sense an experimenter in applied psychology. His experiments were clinical, intended to discover what theories would work well in the treatment of neurotic patients. Early in his career he was momentarily disturbed to find that his female patients were likely to fall violently in love with him during the long course of a psychoanalysis. His hypothesis was that these patients were not in love with him as an individual, exactly, but rather as a father substitute, and he inferred that the emotional attachment would flatten out if he maintained a professional attitude and allowed the patients to use him as a father substitute while working out their emotional problems. The hypothesis seemed to work very well in many cases, though it must be admitted that the success of the treatment does not demonstrate the truth of Freud's conceptions, since somewhat different hypotheses would predict the same result.

Freud put out an enormous number of hypotheses, or assertions, applicable not to clinical practice alone but to everyday life, and it is strange that more of them have not been tried out by psychologists. Recently certain experiments on conflict and frustration, more or less definitely suggested by Freud's writings, have found their way into the laboratory with interesting and promising results. Undoubtedly many of Freud's dicta would not stand up in an experiment, at least in their original form, though they might be suggestive.

Pavlov's "experimental neurosis," an outgrowth of

his conditioned reflex experiment, appears at present to be a promising lead for the laboratory man, perhaps more promising than most of the Freudian hypotheses. We can not expect a dog's or a rat's neurosis to be identical with that of a human being, and we can not hope to carry over the results of the animal laboratory directly into the psychiatric clinic. But something has been gained when we know definite procedures for creating a condition of nervous instability in an animal, especially if we can also discover how to bring him out of that condition.

Child Development

The question, how an abnormal condition arises, is part of the broader problem of tracing the development of the individual and discovering the factors that promote, impede or modify development. This is a problem now being fruitfully attacked by many psychologists by the method of following the child through from birth to maturity. Tests and laboratory methods are used to give an exact knowledge of the course of development and to reveal differences between children in relation to their parentage and environment. But a developmental experiment in the full sense is not easily carried out with human subjects. The psychologist must not introduce experimental factors which might result in mental deficiency or abnormality. He could introduce conditions such as would probably improve the child's development, but he seldom has sufficient control over the child and family to insure a clean-cut result. Attempts are being made, however, and no doubt we can expect increasing success as the work continues.

Survey Experiments and Tests of Hypotheses

The complaint is often heard, as we have already found, that laboratory conditions are too much unlike those of everyday life to throw any light on life and behavior. The complaint is only partially justified. We must distinguish two types of experiment. There is the exploratory type which surveys a field of phenomena in the hope of turning up something that may be of significance. The keen observer, in well-known historic instances, has obtained leads from such surveys that have carried him along to important discoveries. It is decidedly worth while for the psychologist to discover how the individual acts in a variety of conditions, including certainly the conditions of everyday life.

The other type of experiment is pointed up to check some definite hypothesis; and here there is no need to keep the conditions lifelike if only they are such as will provide a clean test of the hypothesis. The hypothesis itself should have some bearing on everyday life, but the question of its truth or falsity is sometimes best put to the test by introducing conditions that are artificial or at least unusual. This is true of some of the best experiments in the older sciences. What is the use, some one might ask, of experimenting to see how a bullet and a feather fall in a vacuum, since in nature they never do fall in a vacuum? The answer is that the experiment provides a definite check on a proposed law of falling bodies. In applying the results to the fall of bodies in the air a correction must of course be made for the resistance of the air, and in the same way a correction will often be necessary when the findings of the psychological laboratory are applied in the clinic, the schoolroom or the athletic field. Just as the engineer must make experiments of his own to determine how the general laws of physics will work out in a complex system like an airplane moving at high speed, so the applied psychologist needs to take over from the experimentalist not his results only but his attitude and general method.

One who has lived through a large share of the history of experimental psychology is sometimes asked whether the present generation of experimenters, so greatly exceeding in number the small band of the old pioneers, measures up to their level in quality of work, and whether any substantial body of scientific knowledge has been built by the assiduous labor of half a century and more. My own answer to both these questions is in the affirmative. My impression of the younger men is that they stand comparison very well with the older group. And any one who takes the trouble to compare their background with that provided by the older psychology will soon realize that there has been a great advance. The results of experimental psychology are not as yet well systematized, and there are large gaps in our knowledge, but the present state of the science is a challenge to the younger men rather than any ground for discouragement.

OBITUARY

VICTOR JOLLOS

1887–1941

Dr. Victor Jollos, a leading student of heredity and mutation, died suddenly at Madison, Wisconsin, July 5, 1941, following a short period of ill health. He was born in Odessa, Russia, on August 12, 1887, the son of Gregor Jollos and Rosa Jurowsky Jollos.

Dr. Jollos spent his entire youth in Germany, where his parents had established residence before his birth.

He received his high-school education in Heidelberg and Berlin, and studied at the Universities of Munich and Berlin under R. Hertwig and M. Hartmann, both of whom influenced him considerably. In 1910 he received his Ph.D. degree in zoology from the University of Munich, and in 1918 he completed the Medizinisches Staatsexamen, and received the German state license for the practice of medicine, following conclusion of his medical studies at the University of Berlin.

Serving as research assistant at the Robert Koch Institute, Berlin, during 1912–1914, Dr. Jollos became acting head of the institute's protozoology department in the latter year. After the war, during which he did medical work, he was appointed research assistant in the Kaiser Wilhelm Institut f. Biologie, Berlin-Dahlem, continuing in that position until 1925. From 1921–1925, he also served as privatdozent for zoology at the University of Berlin.

Upon invitation of the Egyptian Government, Dr. Jollos became professor of zoology and head of the zoology department, which he organized and administered for four years, at the newly created Egyptian University, Cairo, in 1925. While in Egypt, he also was a member of the board of examiners for the medical and veterinary medicine schools in Cairo, served as special adviser to the Egyptian Ministry of Agriculture on sheep and poultry breeding experiments, and was president of the Royal Zoological Society of Egypt.

Returning to Germany in 1929, he became associate professor of zoology in charge of protozoology at the University of Berlin, and was appointed to head a special research laboratory at the Kaiser Wilhelm Institut f. Biologie. Dr. Jollos and his family left Germany after the rise of the Hitler régime, and after a brief interval at the University of Edinburgh, came to the United States in 1934, acquiring American citizenship in 1939.

Under auspices of the Committee in Aid of Displaced German Scholars and the Rockefeller Foundation, Dr. Jollos received a temporary appointment as visiting professor of zoology and genetics at the University of Wisconsin. After expiration of this appointment he was named Carl Schurz memorial lecturer at the University of Wisconsin for a short period, and continued research in genetics under a grant-in-aid from the National Research Council until 1939. In the spring of 1937 he undertook a lecture tour of several eastern universities, speaking at the departments of zoology of Yale University, the Johns Hopkins University, the University of Rochester, N. Y., and Amherst College. He had made his home in Madison since his arrival in this country.

Dr. Jollos's interests in biology were unusually broad and profound. During his almost 30 years of research experience, he worked on varied problems of genetics, parasitic and general protozoology and general biology. His early investigations were primarily in protozoology and later, when certain problems of genetics and evolution commanded his attention, much of his work was done with the Protozoa. His most important research work in genetics dealt with problems of the rôle of environmental conditions in the production of hereditary alterations. This was foreshadowed as early as 1913, when he published a preliminary report of experiments dealing with the acquisition of resistance to poison by pure lines of infusoria.

Perhaps Dr. Jollos's best-known work in genetics is that on *Dauermodifikationen*. In a series of papers, beginning in 1921, he showed that certain external conditions change particular characters of the organism, and that the change reappears in succeeding generations in a gradually lessening degree until it finally disappears. Experiments on Protozoa and Metazoa demonstrated that the change is cytoplasmic, and suggested that it is gradually overcome by the genes. This pioneer work, which opened up an important new field of research, is now recognized as classical.

During recent years he gave much attention to the origin and nature of mutations, seeking especially to test further the view he had earlier announced, but which other investigators had failed to confirm, that certain environmental factors, such as heat, which can produce mutations, may also have a directive influence on the character of the change. Being himself unable to reproduce his initial results, Dr. Jollos sought to improve the experimental technique he had used so as to bring under control some environmental factors which he suspected were responsible for the discrepancies. Unhappily the opportunity he so earnestly desired to pursue this work further never came to him.

Close associates of Victor Jollos recognized his fine scholarly character and the extraordinary extent of his scientific and general knowledge. He was inclined to work alone in his methodical, persevering way, seeking to apply every possible experimental test to the ideas which flowed freely from his fertile and severely logical mind. He provided a fine stimulus to advanced students, and willingly gave his time in their behalf.

Dr. Jollos published more than 50 books, pamphlets, articles and papers during his lifetime, most of them dealing with specific phases of modification, heredity, protozoology and general biology. His immense knowledge of biological literature found expression in a number of monographic reviews which were published in different German handbooks. He wrote seven papers and one book since coming to this country, his

last published work being a book on the fundamentals of heredity with special emphasis on mutations and modifications. It appeared in 1939.

Dr. Jollos also left two unpublished books, one of which, a history of protozoology, he was working on at the time of his death, while the other, a general history of science and biology, tentatively entitled "Problems of Life," was written in 1936.

In 1920 Dr. Jollos married Ilse Raven, an accomplished pianist and teacher, who, with their two daughters, Miss Eva Jollos, a Madison newspaper reporter, and Miss Inge Jollos, a University of Wisconsin student, is now living in Madison, Wisconsin. His mother; a sister, Dr. Nadia Jollos, and a brother, Dr. Waldemar Jollos, in Zurich, Switzerland, also survive him.

R. A. BRINK

UNIVERSITY OF WISCONSIN

DEATHS AND MEMORIALS

DR. WILLIAM FRANCIS GANONG, from 1894 until his retirement with the title emeritus in 1932 professor of botany and director of the botanical garden of Smith College, died on September 9, at the age of seventy-seven years.

DR. WALTER GRANGER, curator of fossil mammals of the American Museum of Natural History in New York and a member of the staff for more than fifty years, died on September 6. He was sixty-eight years old.

DR. ERNEST JULIUS BERG, who retired last June with the title emeritus from the professorship of electrical engineering at Union College and as dean of the department of engineering, died on September 9 at the age of seventy years. He was engineer and consulting engineer of the General Electric Company from 1892 to 1909.

HARRY GRINDELL-MATTHEWS, the Welsh inventor, died on September 11 at the age of sixty-one years. In recent years he had been engaged in research on air defense. He had worked on radio, the synchronization of action in sound films, on wireless telephoning and on wireless control of torpedoes, airplanes and motor boats.

A CORRESPONDENT writes: "Miss Clyde Schuman, 420 Riverside Drive, New York City, is writing a biography of Mary Swartz Rose, until her death last February a member of the faculty at Teachers College, Columbia University, and one of the country's foremost authorities on nutrition. After graduating from Denison University in 1901, Dr. Rose attended Mechanics Institute, Rochester, N. Y., then taught in Fond du Lac, Wisconsin, for three years. She then studied at Teachers College and at Yale. In 1909 she joined the staff at Teachers College, becoming full professor in the department of nutrition in 1921. Miss Schuman will be grateful for letters from persons having notes on her lectures or comments on her educational and scientific procedures; from those who knew her as fellow-student; from those serving with her on national and international committees; and from friends who may have pertinent information. Full credit will be given for material used and any material submitted will be promptly copied and returned."

SCIENTIFIC EVENTS

THE BRITISH COUNCIL

THE report of the British Council covering the year ended March 31 has been made public. According to an abstract in *Nature*, the council has recognized two main duties, first, the defensive role in the resistance to and disproval of charges brought by German and Italian propaganda and, second, the positive mission of carrying to other countries a knowledge of the contribution which Great Britain has made and still makes towards the science of life and government.

The chief methods adopted by the council for this purpose are the formation of new or the encouragement of existing British cultural centers abroad, and the council is now responsible for British institutes in Malta, Cypress, Palestine, Egypt, Iraq, Spain and Portugal. Most of the anglophil societies encouraged by the council are now found in Latin America although before the war the council was in touch with no less than two hundred and fifty such societies, many in France, Germany, the Netherlands and Scandinavia. The council also encourages British schools abroad as well as English studies in foreign schools and universities, and throughout these institutions and elsewhere the knowledge of the English language. Competitive scholarships, valued at £250, are awarded to well-qualified, post-graduate students from foreign countries and from the Empire.

Such activities have been inevitably modified by the war. One of the council's main tasks has been to build up in the premises of the anglophil societies of British institutes and also in foreign universities and other institutions general libraries of English books and to this has been added the presentation of scientific and technical works to specialist libraries abroad. A book export scheme has been initiated to encourage the sale abroad of British books of cultural importance as well as a book review scheme intended to secure the review of British books in foreign newspapers and periodicals.

A small fortnightly publication has been issued

since March, 1939, under the title "Britain To-day," containing generally an editorial and three articles written for the foreign reader on subjects which may be expected to be of interest to him. Reference is also made to the work of the council in regard to films, particularly the commission of documentary films on carefully chosen subjects dealing with British life and achievements and the commission or acquisition of films intended for educational purposes abroad or describing scientific or technical achievements which it is desired to make known abroad. An Advisory Scientific Committee has also been formed which it is intended should work in three or more panels, one under the chairmanship of Sir William Bragg dealing with pure science, a second under the chairmanship of Sir Edward Mellanby dealing with medicine and a third under the chairmanship of Sir William Larke dealing with engineering. Sir William Bragg is also chairman of the Advisory Scientific Committee as a whole.

Previously, the council's interest in scientific publicity was shown chiefly in cooperation with the British Medical Information Service, the dispatch of a number of scientific and learned periodicals and books abroad including a complete section of the South American Book Exhibition, the preparation of a Spanish hand-book of British industrial practice, in conjunction with the British Standards Institution, and the presentation of equipment to a hospital in Sana'a and to a bacteriological institute in Chile.

PREFERENCE RATING FOR RESEARCH SUPPLIES AND EQUIPMENT

THE *Journal* of the American Medical Association writes that the great importance of scientific research to the defense program has just been recognized by granting a high defense priority rating to equipment needed by research laboratories. The Director of Priorities, E. R. Stettinius, Jr., signed an order which became effective on August 30 and remains effective until February 28, 1942, granting the priority rating of A-2 to such equipment. There are in the United States some two thousand research laboratories which use small quantities of about five thousand chemicals and require in their work twenty-five thousand different instruments.

Any laboratory having difficulty in securing essential materials for scientific research and wishing to qualify for the A-2 rating should apply to the Office of Production Management, Chemical Branch, Washington, D. C., on form PD-88. In its application the laboratory must state the type of service rendered or products manufactured. The Office of Production Management has entered into an agreement with the National Academy of Sciences whereby the Division of Priorities will have the benefit of the advice of the academy with respect to all applications received. When a laboratory files an application, it should state the number of copies of the order it desires so that it may apply the rating to deliveries to it by its suppliers if necessary and enable its suppliers in turn to apply the rating to deliveries to them by their subsuppliers. Each order issued to a laboratory will bear a serial number assigned by the Division of Priorities.

If a laboratory is unable to obtain some essential material even with the A-2 rating, it should file an application with the Priorities Division on form PD-1; then, provided the research product is considered sufficiently important, the Priorities Division will issue an individual preference rating certificate, assigning a higher rating to a particular delivery of specified material. Further details concerning this matter may be obtained from the Priorities Division of the Office of Production Management.

THE NEW YORK AQUARIUM

THE New York City Aquarium at Battery Park will be closed at the beginning of October and most of its exhibits will be removed temporarily to the Zoological Park in the Bronx.

At a recent meeting of the Board of Estimate it was proposed to transfer $21,775 from the aquarium budget to the budget of the New York Zoological Society, this sum to cover the cost of providing facilities in the park for some of the fish, aquatic birds, etc., now housed at the aquarium. Opposition to the proposed transfer of budget funds was voiced by George McAneny, spokesman for professional, historical and civic organizations. In common with other speakers opposing it, he feared that the first step was being taken toward ultimate demolition of the ancient landmark. Park Commissioner Moses, however, suggested its retention as a restored Fort Clinton, provided the city were able to appropriate the $182,000 needed for such restoration. Kenneth Dayton, director of the budget, stated that the city would have no funds available for the construction of a building to replace the aquarium.

At this meeting representatives of the New York Zoological Society distributed copies of an architect's drawing showing a possible exhibit to be established at the Zoological Park to house some of the aquatic animals, such as penguins, now in the aquarium. The exact location of the proposed exhibit was not disclosed, but it was indicated that a site had been chosen at a central point in the park.

It is reported that plans are now under consideration for the ultimate establishment at Coney Island of a marine garden, similar to the one recently established in Florida. The plan calls for its construction through some form of authority that will charge an admission fee to support the enterprise.

POSITIONS UNDER THE FEDERAL GOVERNMENT

IN order to staff federal agencies with the thousands of qualified persons needed to carry on defense and regular activities, the Civil Service Commission is announcing examinations in virtually every field of the social and physical sciences. The positions listed below represent some of the many opportunities for government employment.

Industrial Specialists: $2,600 to $5,600 a year. Persons are needed who know industrial methods and processes from first-hand experience in industrial management, planning, engineering, cost accounting, business analysis or research.

Economists: $2,600 to $5,600 a year. Separate employment lists will be established in each grade and for each specialized branch into which the entire field of economics may be subdivided. A 4-year college course in economics is required, with professional research or college teaching.

Research Chemists, Explosives Chemists: $2,600 to $5,600 a year. Qualified persons experienced in chemical investigative work involving the use of recently developed specialized techniques and instruments are being sought for such agencies as the Bureau of Mines in the Department of the Interior and the Bureau of Agricultural Chemistry and Engineering in the Department of Agriculture. A 4-year college course in chemistry or chemical engineering and appropriate experience are required.

Physicists: $2,600 to $5,600 a year. Positions are available in the planning, direction and conducting of investigations or research work in every branch of physics. Four years of college study, with a major in physics, and experience in research or the direction of scientific investigations in a specialized branch of physics must be shown.

Pharmacologists: $2,600 to $4,600 a year. Applicants who show a 4-year college course with major study in pharmacology, pharmacy, toxicology, biochemistry, or a closely related subject, and scientific investigative experience may qualify.

Meteorologists: $2,000 to $5,600 a year. For the junior grade, a 4-year college course with major study in meteorology, physics, engineering, or a closely related subject, plus experience for the higher grades, is required for these highly technical positions.

Technical and Scientific Aids: $1,440 to $2,000 a year. Many government agencies are needing persons trained to do research and testing in radio, explosives, chemistry, physics, metallurgy and fuels. Technical or scientific experience, defense training courses and college study may meet the requirements.

Engineers and Engineering Aids: $1,620 to $5,600 a year. Every field of engineering work is represented. As examples, engineering aids are needed in photogrammetry and topography—engineers for construction, welding and safety work, as well as for research and developmental work on farm machinery and the industrial utilization of surplus agricultural products. Chemical engineers are particularly needed who have had experience with the unit processes of chemical engineering useful in the extraction of manganese, tin, chromium or mercury. Persons with engineering experience and those who have completed engineering study, undergraduate or graduate, are urged to apply. Defense training courses in engineering subjects may satisfy a part of the educational or experience requirements.

Junior Soil Conservationists ($2,000 a year) are needed to work with the technicians in the Soil Conservation Service of the Department of Agriculture and with farmers in planning farms and applying conservation measures. Applicants must have completed an appropriate 4-year college course in agriculture.

For all these positions, and many more, applications will be accepted for several months. No written tests are given, but applicants are rated on their experience, education and training. The Civil Service Commission's representative in any first- or second-class post office can supply further information about these examinations, as well as the proper application forms. Applications should be sent direct to the Civil Service Commission, Washington, D. C., where they will be rated as soon as possible after receipt.

MELLON INSTITUTE TECHNOCHEMICAL LECTURES

A SERIES of lectures on current trends in the American Chemical Industry will be presented by technologic specialists of Mellon Institute of Industrial Research during 1941–1942. These discourses, which will be delivered on alternate Thursdays, from 11:30 A.M. to 12:30 P.M., throughout both semesters, in the auditorium of the institute, will be open to all students of industrial chemistry and chemical engineering in the University of Pittsburgh, as well as to members of the institute.

October 2, Dr. E. R. Weidlein, "Economic Problems of the Chemical Industry."

October 16, Dr. F. W. Adams, "Status of the Manufacture of Heavy Chemicals."

October 30, J. M. Russ, "Significance of Industrial Synthetic Organic Chemistry."

November 20, Dr. H. J. Rose, "Industrial Opportunities in Fuel Technology."

December 4, Dr. W. A. Gruse, "Recent Scientific Advances in Petroleum Technology."

January 8, Dr. R. L. Wakeman, "Status of the Manufacture of Plastics."

January 22, Dr. E. E. Marbaker, "Vitreous Enamels—A Key Industry."

February 12, Dr. H. E. Simpson, "Present Problems in Building Materials Technology."

February 26, R. H. Heilman, "Economic Importance of Heat-Insulating Materials."

March 5, Dr. G. H. Young, "Major Problems in Corrosion."

March 19, Dr. R. C. Johnson, "Utilization of Important Mineral Wastes."

April 2, Dr. P. J. Wilson, Jr., "Progress in Industrial Waste Disposal."

April 23, R. D. Hoak, "Major Problems in Sanitation."

May 7, Dr. H. B. Meller, "The Maintenance of Health in the Chemical Industry."

THE WISCONSIN MEETING OF THE NATIONAL ACADEMY OF SCIENCES

THE autumn meeting of the National Academy of Sciences will be held at the University of Wisconsin on October 13, 14 and 15. There will be an address of welcome on Monday morning, October 13, by President Clarence A. Dykstra, of the university, and a response by Dr. Frank B. Jewett, president of the academy. In the afternoon there will be a reception by President and Mrs. Dykstra.

The public lecture will be given in the evening by Dr. Zay Jeffries, of the Nela Park Laboratory at Cleveland of the General Electric Company. Preceding the lecture there will be an informal subscription dinner at the Wisconsin Union. A reception is planned for Tuesday evening, followed by a second subscription dinner. Each day luncheon will be served at the Wisconsin Union. On the afternoon of Wednesday a visit is planned to the Forest Products Laboratory.

Scientific sessions are planned for each morning. Members of the academy who expect to present papers or to introduce guests presenting papers are requested to send to Dr. Joel Stebbins, Washburn Observatory, University of Wisconsin, the full titles and three abstracts of each paper. In accordance with the custom of the academy a maximum of fifteen minutes will be allowed for the presentation of each paper.

Members of the committee of arrangements are: B. M. Duggar, *chairman;* C. E. Allen, Gregory Breit, E. B. Fred, L. R. Jones, C. K. Leith, Joel Stebbins, E. B. Van Vleck, all of the University of Wisconsin, and, *ex-officio,* F. E. Wright, home secretary of the academy.

SCIENTIFIC NOTES AND NEWS

THE American Association for the Advancement of Science meets in Chicago from September 22 to 27 in conjunction with the celebration of the fiftieth anniversary of the founding of the University of Chicago. The program consists mainly of the symposia and addresses, full accounts of which have been printed in the issues of SCIENCE for July 4 and August 15. The executive committee of the association will meet on Sunday, September 21. From September 27 to 29 following the meeting of the association there will be an academic festival of the University of Chicago, the principal events of which will include an alumni assembly, a service of thanksgiving and commemoration, a reception of delegates, a festival concert and a convention, at which honorary degrees will be conferred.

DURING the recent visit of Dr. Arthur H. Compton, professor of physics of the University of Chicago, to South America as director of the Andean Cosmic Ray Expedition, honorary degrees were conferred on him by the University of San Marcos at Lima and by the University of Arequipa. He was made an honorary member of the Peruvian Chemical Society and a corresponding member of the Brazilian Academy of Sciences and of the Academy of Exact Sciences at Lima.

THE Franklin Medal, awarded for the first time by the Scientific Society of San Antonio, Texas, was presented at the annual dinner of the society to Colonel Charles F. Craig, in recognition of his distinguished work in science. Dr. Craig retired in 1938 as professor of tropical medicine and head of the department at the Medical School of Tulane University, New Orleans.

ON the occasion of the final exercises on September 17 of the celebration of the centenary of Fordham University the degree of doctor of science was conferred on Dr. Gustav Ernst Frederick Lundell, chief chemist of the National Bureau of Standards, and on Dr. N. H. Heck, chief of the Division of Terrestrial Magnetism and Seismology of the U. S. Coast and Geodetic Survey.

DR. B. F. KINGSBURY, emeritus professor of histology and embryology at Cornell University, has been appointed guest professor in the department of anatomy of the University of North Carolina.

DR. ADOLF MEYER, who retired on September 1 as Henry Phipps professor of psychiatry and director of the Psychiatric Clinic of the Johns Hopkins Hospital, is succeeded by Dr. John C. Whitehorn, formerly physiological chemist and director of laboratories at McLean Hospital, Belmont, Mass., since 1938 professor of psychiatry at the Medical School of Washington University, St. Louis.

DR. WALTER REECE BERRYHILL has been elected dean of the School of Medicine and chairman of a newly established division of medical sciences of the University of North Carolina. He has been acting dean of the Medical School since the resignation a year ago of Dr. W. de B. MacNider.

AT the University of Rochester the following promotions have been announced: Dr. Curt Stern, from associate professor of zoology to professor of experimental zoology, and Dr. Sherman C. Bishop, from junior professor of zoology to professor of vertebrate zoology. Promotions from assistant to associate professor are: Dr. Sidney W. Barnes, physics; Dr. David R. Goddard, botany; from instructor to assistant professor, Dr. Richard H. Goodwin, botany; Dr. John W. Green, mathematics; Dr. Orrington E. Dwyer, chemical engineering, and Dr. John B. Buck, zoology. Dr. John D. Coakley, research fellow in psychology, has been appointed to an instructorship, and Harrison D. Stalker, teaching assistant in zoology, has been made research assistant. Dr. Harry D. Bouman has been appointed assistant professor of psychology and Dr. Gerhard Dessauer, research associate in physics. New instructors are: Dr. Warren D. McPhee, chemistry; Dr. Lowry B. Karnes, geology; Dr. Joseph B. Platt, physics; Dr. Hobart M. Smith, zoology, and Dr. Howard H. Rostorfer, physiology (vital economics).

PROFESSOR WALTER G. WHITMAN, head of the department of chemical engineering of the Massachusetts Institute of Technology, has been appointed oil consultant for the Office of Production Management. He succeeds Dr. Robert E. Wilson, president of the Pan-American Petroleum and Transport Company, New York, a director of the American Chemical Society, who has resigned after serving thirteen months.

W. G. TAGGART, since 1913 assistant director of the Agricultural Experiment Stations of the Louisiana State University, has been named director. He succeeds Dr. C. T. Dowell, director since 1928, who becomes professor of agronomy on the faculty of the College of Agriculture.

T. R. RHEA, since 1924 a member of the staff of the General Electric Company, Schenectady, N. Y., has been appointed engineer of the new chemical section in the department of industrial engineering of the company. The section has been established to carry on activities that heretofore have been a part of the work of the mining section.

DR. B. D. EVANS, assistant director of the Royal Observatory at Hong Kong, has been made director.

THE Committee of the British Privy Council for the Organization and Development of Agricultural Research has appointed Major James Keith, Professor F. T. Brooks, Professor D. Keilin, Professor J. A. Scott Watson and Professor C. R. Harington as members of the Agricultural Research Council.

DR. W. RALPH SINGLETON, associate geneticist at the Agricultural Experiment Station at New Haven, has leave of absence to enable him to accept an invitation to conduct courses in genetics during the fall term at the University of Minnesota. He will take the place of Professor H. K. Hayes, who is on a mission to Peru.

PROFESSOR W. WARREN STIFLER and Professor Theodore Soller, of the department of physics of Amherst College, have been given leave of absence for one year to enable them to engage in work for national defense. Professor Stifler will conduct special courses in optics at Columbia University and Professor Soller will engage in research at the Massachusetts Institute of Technology. In their absence from Amherst Professor Claude R. Fountain, professor at Peabody College for Teachers at Nashville, Tenn., has been appointed visiting professor of physics.

DR. JAY L. LUSH, of the department of animal husbandry of the Iowa State College, will devote the autumn to a journey to South America. He has accepted the invitation of G. G. Carneiro, director of the Agricultural College of Minas Geraes, Brazil, to be guest lecturer at that school. While there he will give lectures on breeding systems, and will conduct conferences on animal breeding and on research methods and problems of animal husbandry.

THE autumn meeting of the American Society of Mechanical Engineers will be held from October 12 to 15 at Louisville, Ky.

THE annual meeting of the Midwest Museums Conference of the American Association of Museums will be held at Fort Wayne, Ind., on October 17 and 18.

THE eleventh annual meeting of the American Malacological Union was held in Thomaston and Rockland, Maine, from August 26 to 29. Norman W. Lermond, director of the Knox Academy of Arts and Sciences, Thomaston, was convention host. A special feature of the program was a symposium on "Methods of Collecting and Preserving Mollusks" of which Dr. B. R. Bales, Circleville, Ohio, was chairman. Frank Collins Baker, University of Illinois, was elected president and Dr. Louise M. Perry, Asheville, N. C., vice-president.

A SYMPOSIUM on "Life in High Altitudes and Aviation Medicine" will be presented on the morning of September 23 in conjunction with the fiftieth anniversary celebration of the University of Chicago. The speakers include Dr. Carlos Monge, professor of medicine at the University of San Marcos, Lima, Peru; Dr. David Bruce Dill, Major, Air Corps, United States Army; Dr. A. C. Ivy, professor of physiology and pharmacology at the Medical School of Northwestern University, and Dr. E. S. Guzmán Barron, assistant professor of biochemistry at the Lasker Foundation of the University of Chicago.

THE London correspondent of the *Journal* of the American Medical Association reports that the British Minister of Health has appointed an expert committee to review the present and future requirements of vegetable drugs in the light of empire consumption and trade and facilities for cultivation within the empire; to consider the steps which should be taken to secure organization of cultivation and collection, and to make recommendations. This committee has now presented an interim report which differentiates two groups of drugs—a long-term and a short-term group. It is held to be unlikely that any long-term policy will materially affect the supply of drugs during the present emergency, as the period preceding production would be too long. The committee considers that in the United Kingdom attention should be concentrated on the production of agar, dill, belladonna, Irish moss, colchicum, digitalis, ergot, male fern, liquorice root, hyoscyamus, peppermint, psyllium, sphagnum moss, stramonium, dandelion root and valerian. Arrangements have been made by the Ministry of Health to extend the areas of cultivation of certain extremely important drugs. The Royal Botanic Gardens have arranged with the National Federation of Women's Institutes to organize the collection of ten important herbs in each county, making a total of thirty herbs throughout the country.

IN the administration and instruction building of the Montreal Botanical Gardens there was opened on August 28 a new laboratory to be known as the John Dearness Laboratory for Plant Pathology. Dr. Dearness attended and delivered the opening address. He was presented by Dr. Marie-Victorin, head of the department of botany of the University of Montreal. This laboratory has been established under the auspices of the Faculty of Sciences and the Botanical Institute connected with the university. The event was included in the program of the closing afternoon of the summer meeting of the Mycological Society of America which this year was held in the Montreal district with headquarters in Macdonald College. Dr. Walter Snell, of Brown University, vice-president of the society, participated in the proceedings.

WE learn from *Nature* that in regard to the coordination of the universities and research institutions in India with the development and extension of industrial research, attempts are being made to obtain the cooperation of the universities in preparing the combined list of industrial researches completed, in progress and proposed to be undertaken in government laboratories, universities and research institutions in India. Publication of an annual combined list is contemplated. The report on the work of the Industrial Research Bureau also refers to the coordination of universities and research institutions. The number of laboratories in India capable of undertaking industrial research work is limited, and after considerable attention had been given to the matter it has been decided to provide funds to be allocated to selected institutions for the payment of grants to workers engaged in research falling within the programs to be arranged on the recommendations of the Board of Scientific and Industrial Research.

A WIRELESS to *The New York Times* states that a decree of discrimination against Jewish physicians and surgeons has been announced at Vichy. The proportion of Jews to non-Jews must not exceed two per cent., as is already fixed for the legal profession. Exemptions are provided for Jews who have rendered signal service to France. Before the exodus of Jews from Central and Southeastern Europe in the years immediately preceding the war, it was computed that Jews in France represented 2.4 per cent. of the total population. The law relates to Jews of French nationality. Alien Jewish physicians were barred from practicing several months ago. Thus laws affecting Jews are being made operative in the unoccupied zone of France. In the occupied zone, the Nuremberg "ghetto laws" are applied.

DISCUSSION

AN INTRODUCTORY COURSE IN BASIC PHYSICS

IN connection with Professor S. R. Williams's article in your issue of April 25th, entitled "Physicists Needed for National Defense Work," Professor Williams has suggested that I should call attention to the introductory course in basic physics which has been given for several years at Stevens Institute of Technology. This course was organized to present basic physics in a rigorous quantitative way. Calculus is used as soon as it is needed, which is almost from the start, and is currently taught in the mathematics department. Engineering naturally provides the best quantitative examples of basic physical laws.

On the theory that a man's intelligence practically reaches its ultimate growth by the age of eighteen, we are presenting to freshmen some topics previously taught to juniors and seniors—for example, the speed fluctuation of an engine and transients in electric circuits.

The course in the two freshman semesters includes mechanics and electricity. Since it has previously been described in some detail,[1] I shall merely com-

[1] Alan Hazeltine, *Journal of Engineering Education*, 30: 699, April, 1940.

ment on some salient features and on the results obtained.

All basic physical concepts and laws are derived from certain general observations, which are the axioms of physics. To express these observations, certain fundamental quantities (the mathematicians' undefined elements) are constructed, namely, distance, time, energy and electric quantity. And to formulate the consequences of these observations, many derived quantities are introduced, such as velocity, force, voltage, magnetic flux. In their quantitative aspect, these derived quantities usually enter as proportionality factors in special cases, and receive their general definitions as derivatives: velocity as the time derivative of distance, force as the distance derivative of energy, voltage as the derivative of energy with respect to electric quantity. A few derived quantities appear as integrals: momentum as the time integral of force and magnetic flux as the time integral of induced voltage. The student is taught to think first of a derivative as the slope of a graph and of an integral as the area under a graph; only in special cases are they directions to perform analytical operations.

The unconventional arrangement of giving electricity immediately after mechanics in the same course was chosen on account of the very close analogies: electrostatics is electrical elasticity and electromagnetism is electrical kinetics. This analogy is emphasized to increase the comprehension of both subjects.

The mechanics, especially elasticity and kinetics, forms the basis of the sophomore work in mechanical waves and sound; and the electricity forms the basis of the sophomore work in electrical fields and electric waves. Light then is introduced as an electric wave; and the laws of reflection and refraction are derived from those of dielectric and magnetic fluxes. (The sophomore work also includes heat, based on the Carnot cycle, and kinetic theory, electronics and an introduction to some of the more recent physical concepts.)

Our present physics course is more difficult for the student, is longer and results in lower average grades, than the course of a few years ago. Nevertheless, the response of the students is gratifying. Physics here is not an unpopular subject. There seems to be a trend in some places toward more superficial physics teaching, with the hope of making the physics course easier and hence more popular. As Professor Williams indicated, this is in the wrong direction: physics should be made more popular by being made more worth while. The late President Humphreys of Stevens often used to say: "Superficiality is the curse of American education."

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COLLECTION AND FILING OF ABSORPTION SPECTRA DATA

THE literature of absorption spectra is so widely scattered that frequently when a long search reveals that measurements have been made for a compound, the data are inconvenient to obtain. Too often no data at all can be located for compounds which have been known for a long time and which most certainly have been studied. The preparation of a new and complete but traditional atlas would offer no solution because it would be expensive to produce and, hence, limited in distribution, and because it would be rendered obsolete quickly by the publication of new data.

It is the purpose of this communication to suggest that a master card file of existing data be established at some central depository. Here the data and references for each substance or group of substances would be assembled in standard form, each upon a separate card. Once established such an index would be perpetually up to date if authors could be induced to supply their new data automatically and promptly. Photoprints or microfilm of the available data for any compound could then be furnished quickly at a small fee, and at moderate expense, institutions would be able to obtain more or less complete duplicate files. In this way it would be possible to avoid the expense of duplicating uninteresting and unnecessary information, thereby reducing the cost of the data actually wanted.

Compilation of the Absorption Spectra Card Atlas proposed above would facilitate and stimulate research and should deserve the support of some fund for scientific advancement. Once prepared the fees for supplying information should support the atlas.

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THE OCCURRENCE OF FRESHWATER SPONGES IN THE HAWAIIAN ISLANDS

THE occurrence and distribution of freshwater sponges in Polynesia is still little known, due, perhaps, either to the lack of interest in or recognition of these interesting animals on the part of most collectors who are out for "bigger game."

Up to the present time the Fijian Islands seem to be the easternmost locality from which freshwater sponges have been recorded in Polynesia; for *Spongilla gilsoni* Topsent[1] has been collected and described from these islands.

Mumford[2] and Adamson,[3] in very interesting articles dealing with the distribution of the terrestrial

[1] Emile Topsent, 5: 187–191, 1912.
[2] E. P. Mumford, *Ecology*, 17: 1, 143–157, 1936.
[3] A. M. Adamson, *B. P. Bishop Museum Bulletin* No. 159, pp. 1–93.

and freshwater faunas of the Marquesas Islands, do not mention freshwater sponges from this island group. Mumford cites Gee, who believes that they may occur here and will turn up eventually as a result of further collecting.

From my own experience in collecting in the Hawaiian Islands during the summer of 1935, I am convinced that freshwater sponges may occur in many of these Pacific Islands. Although Perkins's[4] excellent work on the fauna of the Hawaiian Islands does not mention the presence of these animals, yet during the latter part of July, 1935, I found freshwater sponges in a pool at the bottom of a waterfall at Haepuaena on the Island of Maui. These sponges, vividly green in color and very apparent in the clear water of the pool, were found in large masses encrusting the undersides of rocks and submerged pieces of wood. A request for information concerning the distribution and occurrence of freshwater sponges in Hawaii was made to Dr. E. H. Bryan, Jr., curator of collections of the B. P. Bishop Museum in Honolulu, with the resulting information that Dr. Otto Degener of Honolulu had upon several occasions collected these animals in various parts of the Hawaiian Islands. A request to examine these specimens failed to elicit them, since they apparently had been lost. However, Dr. Degener very kindly sent me specimens which he had collected during the month of February, 1936, on the Island of Oahu. An examination of these two specimens reveal them to be *Heteromyenia baileyi*. Thus as a result of these collections the occurrence of freshwater sponges in the Hawaiian Islands is established for the first time, and the known distribution of these sponges in Polynesia is greatly extended both to the north and east.

ARTHUR SVIHLA

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EARLIEST LAND VERTEBRATES OF THIS CONTINENT

ALTHOUGH discovery of amphibian remains in Greenland in deposits close to the Devonian-Carboniferous boundary[1] makes it certain that the origin of land vertebrates occurred in the Devonian Period, we know little of their history until a much later date. In American terminology the Carboniferous is customarily divided into two periods, the Mississippian (lower) and Pennsylvanian (upper). In the Coal Measures of the latter part of the Pennsylvanian, amphibians already well advanced and specialized are numerous and fairly adequately known. But for the entire stretch of time between the beginning of the Carboniferous and the Coal Measures, a period of perhaps 50 to 75 millions of years, land vertebrates, save for footprints, are almost unknown. In Scotland a dozen or so specimens have been found in late Mississippian deposits.[2] Not a single bone has been reported from Carboniferous rocks below the Coal Measures in any other area of the globe.

Last winter the presence of vertebrate remains in the Carboniferous shales of the Hinton District of West Virginia was reported to us by Mr. Harry Damron, graduate student at Harvard University; this locality has been investigated, under his guidance, by R. V. Witter and the writer. In addition to fishes the deposit contained numerous remains of amphibians. Unfortunately the bones are disarticulated and often fragmentary, so that their morphological value is limited. Stratigraphically, however, they are of great interest. Amphibians had been found in various instances in relatively late deposits in the Appalachian coal field area, and we had assumed that the present locality would also prove to be Pennsylvanian in age. To our surprise and delight it proved to be much earlier. The horizon is that of the Hinton shales of the Mauch Chunk Group. These amphibians are thus Mississippian in age. They are exceeded in antiquity only by the Greenland skulls mentioned above, and equalled only by the Scottish materials; they are by far the oldest skeletal remains of tetrapods in continental North America. Despite their incomplete nature these bones are thus important documents in the deciphering of the early history of land life.

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QUOTATIONS

SOIL FERTILITY

A SPIRITED correspondence has followed Lord Cranworth's warning that soil fertility may become exhausted by the pace of the war-time food production campaign, and has brought out several points which have vital significance for the nation as well as for farmers. Larger quantities than ever before of fertilizers, such as superphosphate and sulphate of ammonia, have been applied to the land in the past year, and as a result heavier crops have been grown. It has been the deliberate policy of the government to secure increased supplies of fertilizers and to see that

[4] R. C. L. Perkins, "Fauna Hawaiiensis," Introduction, 1913.

[1] Säve-Söderberg, G. Meddelelser om Grønland, Bd. 94, Nr. 7, 105 pp., 1932.

[2] These have been reviewed by D. M. S. Watson, Palaeont. Hungarica, *I*, 221–252, 1926.

they are applied to the land. In many cases farmers who until now have made little use of fertilizers were ordered by the War Agricultural Committees to give their corn a dressing this spring, and there is no question that this provision of extra supplies of available plant food in the top soil has given the country bigger crops than could otherwise have been expected.

It is true that this has been an exceptional growing season, and that the growth of some crops was so lush that the straw did not stand battering by wind and rain and patches of corn are now lying flat. Even so, on balance the nation will gain extra crops. In a few of the worst cases the promise of extra grain has been lost and the farmer is faced with a heavy task in saving what he can. That is part of the gamble that is inherent in farming in an uncertain climate. Last harvest there was no such trouble, however generously chemical fertilizers had been applied. This year the trouble is not confined to fields where sulphate of ammonia was used. Some of the laid corn is to be found on land newly ploughed out of old grass rich in plant food. The lesson to be learned is surely that chemical fertilizers used prudently can greatly increase the yield of crops—especially if the farmer knows enough about his business to grow the stiffer strawed varieties of corn that will stand to harvest on well-fed land even in an exuberant season like this.

Everywhere farmers with long experience of arable farming will vouch for the value of chemical fertilizers when used properly as a supplement to the organic matter in the soil which provides the reservoir of the plant foods on which the crops draw year after year. In our settled type of farming livestock have long played a dominant part, and, despite the reduction in numbers of pigs and the grass flocks of sheep, they continue to do so to-day. The encouragement lately given to hurdled flocks should bring more sheep on to the lighter arable lands where they can be most valuable in maintaining fertility. Unless the balance of our farming is seriously upset—and there is little prospect of that—there is no risk of soil exhaustion and erosion, such as occurs in the New World, where wheat is grown by the square mile and then the land abandoned while fresh areas are tapped. In this green island we are now ploughing and cropping 4,000,000 more acres than we did two years ago, and dormant fertility lying under the grass sod is being stirred to produce the extra cereals, potatoes, and other crops that the nation needs in war-time. Other fields which have grown a succession of corn crops are being under-sown with clover and grass to grow a productive sward for long enough to allow the store of organic matter to be replenished. There is really no special virtue in dormant fertility.

Moreover, if agriculture is to regain its full place in the nation's life, the soil itself must be alive and fully productive. The tenets of good husbandry are so well understood in this country that the general public need have little fear that the land will suffer if farmers are allowed to use their discretion in developing production. On the contrary, the new life that is stirring in agricultural Britain is one of the few benefits arising from the present conflict that must be allowed to persist in the years after the war.—*The Times, London*

SCIENTIFIC BOOKS

QUALITATIVE ANALYSIS

Elementary Qualitative Analysis. By J. H. REEDY. Third edition. x + 156 pp. New York: McGraw-Hill Book Company. 1941. $1.50.

THERE is a growing trend in colleges to teach qualitative analysis by semi-micro techniques. The obvious advantages are the substitution of centrifuging for filtration and a saving in time and material. This latest edition of Professor Reedy's text adds another to the list of books in which these techniques are used. In the present instance, however, the change is not complete since macro procedures are retained for a few of the analytical steps.

This text is presumably designed for a one-semester course for sophomore students in chemistry. In contrast to the more usual text in this field in which sections on theory, description and analysis are to be found, this book contains only the analysis material. Consequently its use will probably involve a companion text covering the other two parts of the subject.

There are two main parts to the book, a section on cation analysis and another on anion analysis. There is also a brief section on the systematic analysis of various solid substances. In addition to detailed and probably quite satisfactory directions for analysis, the two main sections contain well-organized sets of preliminary experiments and groups of study questions for each of the several groups of ions considered. The cation analysis material takes up the usual restricted list of ions and employs standard methods of separation. There are, however, new procedures for the Tin Sub-Group and for the Alkali Group. The anion analysis section considers an unusually large number of anions. The method of analysis is the now common combination of group eliminations and subsequent specific tests.

The book is well made and printed and typographical errors are infrequent. It does contain a few expressions that depart from common chemical usage. Examples are "complexing" for "complex ion forming" and "alkalize" for "make basic." The definition of a buffer as "a salt that will neutralize a solution" is decidedly unorthodox. For the most part ionic equations are given for reactions in which strong electrolytes are involved, but unfortunately this is not done consistently. Some of the explanations given in the otherwise admirable notes are not in accord with prevalent concepts of inorganic and physical chemistry.

Among the desirable features of this book are the well-organized preliminary experiments and directions for analysis and the adherence to more easily understood inorganic tests. Some teachers will find less desirable the inconsistent treatment of ionic reactions, the paucity of explanations based on quantitative equilibrium data and the occasional inclusion of explanations of doubtful accuracy.

F. A. LONG

Semi-Micro Qualitative Analysis. By CARL J. ENGELDER, Ph.D., professor of analytical chemistry, University of Pittsburgh; TOBIAS H. DUNKELBERGER, Ph.D., assistant professor of chemistry in the Graduate School, Duquesne University; and WILLIAM J. SCHILLER, Ph.D., head, Chemistry Department, Mount Mercy College. Second edition. xii + 305 pp. 15.5 × 23 cm. New York: John Wiley and Sons, Inc. 1940. $2.75.

THE first edition of this book appeared in 1936 and introduced the semi-micro technique in qualitative inorganic analysis, which was readily adopted by many laboratories. The new and enlarged edition will be welcomed by all those interested in qualitative analysis. The theoretical section has been rearranged and modernized. Sets of questions and problems have been inserted at frequent intervals throughout the book, and a new scheme for anion analysis has been added. Many supplementary tests given in the first edition have been omitted. More than 200 references to the original literature are listed in the sections on cation and anion analysis.

JOHN H. YOE

An Introduction to Quantitative Chemical Analysis. By WARREN C. VOSBURGH, professor of chemistry, Duke University. viii + 356 pp. 18 tables, 27 figures. New York: Henry Holt and Company. $2.75.

THE preface states, "This book is designed as a textbook for a quantitative analysis course of about one semester's length in which theory and practice are given about equal weight." Although there are interesting features in the book, it does not rank with leaders in the field.

There are twenty-five chapters covering the usual theoretical and practical aspects of quantitative analysis. Interspersed in this material are twenty-seven exercises which may form the laboratory work of an introductory course. This arrangement of material necessarily causes some duplication and waste of space. In the early part of the book, some topics are perhaps handled in too elementary a manner. The first three chapters contain conventional material regarding apparatus, the use of the balance and calibration of weights. Beginning with chapter four, subject-matter is arranged so that gravimetric analysis is treated first and volumetric methods second. Two chapters on the theory of precipitation cover solubility product and formation of precipitates. Volumetric analysis is presented in the following order: nomenclature and calculations, apparatus and calibration, acidimetry and alkalimetry, hydrogen ion concentration, theory of titration, titrations involving precipitation, oxidation and reduction theory and practice, potassium permanganate, ceric sulfate and iodometry, oxidation potentials. For the most part, this conforms to the older arrangement of a course in quantitative analysis and has several advantages. There will be differences of opinion regarding the manner in which subject-matter has been handled. One or two illustrations will suffice. This reviewer believes that the presentation of "the titration of weak acids," "buffers" is inadequate. A fault is shared with other texts in that very little space is devoted to the discussion of water and to the preparation of samples in spite of the fact that the analysis is no better than the selection and preparation of the samples. Alternative parts of procedures are placed in the body of some of the exercises, a confusing method. It is believed that alternative sections should come at the end of the procedure or be placed in the footnotes. A final illustration concerns the choice of procedures and the order of presentation. Particularly in that section of the book which deals with gravimetric analysis, one gains the impression that the exercises are separate, independent procedures, unrelated to one another. The ideal course should be developed so that starting with simple principles and gradually adding more complex ones, a fundamentally sound, although elemental, picture of quantitative analysis is produced at the end of the semester. This text falls short of this goal. Gravimetric iron, phosphorus and magnesium are presented as independent, almost unrelated, procedures, and limestone or natural rock are barely mentioned. Thus a rare opportunity is missed to present an important relationship between qualitative and quantitative analysis and to determine more than one element in one sample. Adequate presentation of solution of

natural samples is also omitted. There are some good sections in the book. The use of definite exercises facilitates the organization of a course. In general, the reaction of the reviewer toward this text is unenthusiastic.

VILLIERS W. MELOCHE

Ionic Equilibrium as Applied to Qualitative Analysis. By T. R. HOGNESS and WARREN C. JOHNSON, both at the University of Chicago. x + 306 pp., with 18 tables and 23 illustrations. New York: Henry Holt and Company. 1941. $2.00.

ACCORDING to the preface this book "consists of the revised edition of the complete text, 'Qualitative Analysis and Chemical Equilibrium.' It is designed to meet the needs of teachers who either prefer to use their own particular scheme of analytical procedure or want to include in their course supplementary material on chemical equilibrium in the form of problems and exercises."

Separate publication of Part I with minor additions and improvements over the 1937 edition should make this well-known exposition more attractive as a basis for class work. While the Brønsted theory is now included the authors still rightly maintain that its consistent and exclusive use is not advisable—*Cf. Jour. Chem. Education,* 14: 448, 1937.

BYRON A. SOULE

SPECIAL ARTICLES

TYPICAL URINARY CRYSTALS OF THREE SULFANILAMIDE DERIVATIVES PRODUCED IN VITRO[1]

FOLLOWING the administration of sulfapyridine, sulfathiazole or sulfadiazine to humans, corresponding crystals with characteristic shapes may appear in the urine (Fig. 1). These crystals were found to consist for the most part of the acetylated derivatives of the aforementioned compounds. Their appearance, however, is entirely different from the simple rectangular, rhomboid or trapezoid structures which can be obtained by crystallizing the pure acetyl derivatives from water.[1a] It seemed of interest, therefore, to investigate the influence of urine upon the crystal shape of acetylated sulfanilamide compounds.

Crystallization of the pure acetyl derivatives of sulfapyridine, sulfathiazole and sulfadiazine from *normal* human urine gave crystals identical with the simple forms obtained from water. This result remained uninfluenced by the addition of the free compounds to the urine. The presence of sugar and albumin in the specimen likewise had no effect upon the crystal forms. If, however, the urine of patients, receiving one of the above-named sulfanilamide derivatives, was used for crystallization of the acetyl compounds, the forms obtained in a large majority of experiments were identical with *urinary* crystals (Fig. 1), occurring naturally in such urines. The *in vitro* formation of these urinary crystals was not dependent upon the original presence of such forms in the patient's urine. The faculty of producing typical urinary crystals of sulfanilamide derivatives, apparently occurring exclusively in urines of patients receiving the compounds, suggests the presence of a certain substance in these urines responsible for the effect. Experiments on the nature of the crystal-forming reaction are in progress.

The structures of urinary crystals outlined in Fig. 1 are those most commonly encountered. They are

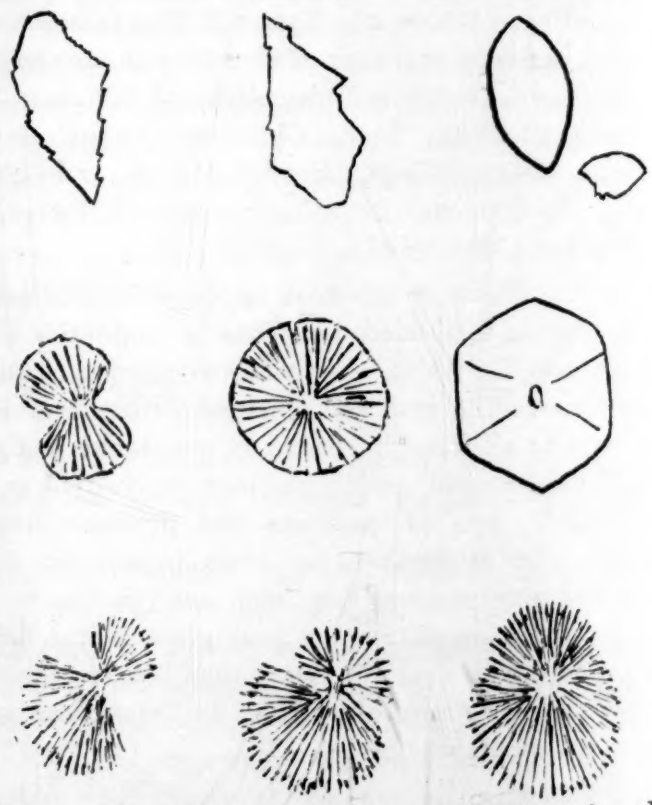

FIG. 1. Crystals appearing in human urine after administration of (top to bottom): *Sulfapyridine*—arrowheads and whetstones. *Sulfathiazole*—Striated dumb-bells (shocks of wheat with central binding), rosettes with radial striations and regular hexagonal platelets (all structures *symmetrical*). *Sulfadiazine*—Striated dumb-bells (shocks of wheat with excentric binding) and shell-forms with radial striations (all structures *asymmetrical*). It is apparent that the sulfathiazole rosettes and the sulfadiazine shells grow out of their respective dumb-bell forms. (Traced from micro-photographs of urinary sediment, enlargement 250 ×)

[1] Aided by a grant from the Sidney C. Keller Research Fund.

[1a] A saturated aqueous solution of any of these urinary crystals contained the acetyl derivative of the respective drug in a concentration which very significantly exceeded the solubility in water of the chemically pure acetylated compound. It was usually about twice as high.

based upon a follow-up study of crystal shapes in urines of 87 patients treated with sulfapyridine, sulfathiazole and sulfadiazine. Though varying in form from individual cases and sometimes even from the same patient on consecutive days, they were found to present forms specific for each of the three compounds investigated. Detailed data on physical and chemical analysis of these crystals will be published elsewhere. (Microphotographs of urinary crystals showing some of the typical sulfapyridine, sulfathiazole and sulfadiazine forms have been presented in several publications.[2, 3, 4, 5])

Crystallization experiments have been carried out with the urines of 51 patients receiving sulfapyridine, sulfathiazole and lately also sulfadiazine. In all specimens investigated, the *in vitro* formation of urinary crystals was attempted with acetylsulfapyridine as well as acetylsulfathiazole, regardless of which of the three compounds had been given to the patient. In recent experiments acetylsulfadiazine also was used.

For crystallization, an excess of the compound is added to the filtered and acidified urine, heated to boiling and immediately filtered. Crystals appear in the filtrate as it cools to room temperature.

It was found that urines of patients receiving sulfathiazole or sulfadiazine usually gave typical urinary crystals with both acetylsulfathiazole and acetylsulfadiazine, while with acetylsulfapyridine the forms obtained from these urines were atypical, although mostly different from crystals of the pure compound in water. Sulfapyridine urines, on the other hand, produced characteristic whetstones or arrowheads with acetylsulfapyridine, whereas the crystals formed with the acetyl products of sulfathiazole and sulfadiazine deviated more or less from their described typical appearance. In some instances sulfapyridine urines produced characteristic urinary crystals with the acetylated compounds of all 3 sulfanilamide derivatives.

Of the 51 urine specimens investigated, in 32 characteristic urinary crystals could be produced with at least one of the 3 compounds. The most typical form was always obtained with the acetyl-derivative of the drug which the patient had received. The shapes produced were identical with those shown in Fig. 1. Sixteen of the urines yielded more or less atypical crystals, while 3 gave negative results (forms as from water). These 3 urines had specific gravities between 1.010 and 1.014. In general it was observed that the production of characteristic urinary crystals may not succeed with highly diluted urines; it can, however, often be achieved with such specimens by concentrating them on the steam-bath before use for crystallization. On the other hand, urines can be depleted of their faculty to form urinary crystals by repeated supersaturation with an acetylated compound and removal of the crystals which appear on cooling. An alkaline reaction will inhibit the production of urinary crystals. The crystal-forming potency can be restored upon acidification. If urinary crystals are recrystallized from normal urine or water they assume the simple shapes which are obtained from water with the pure acetylated compounds. Urines of patients receiving sulfanilamide do not seem to possess the faculty of forming urinary crystals with the 3 compounds studied.

The artificial production of urinary crystals proves that the shapes outlined are specific for the individual compounds and are formed from their acetylated derivatives. The presence of such crystals in the urine, therefore, makes it possible to identify the particular sulfanilamide compound administered to the patient.

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[2] W. Antopol, *Jour. Urolog.*, 43: 589, 1940.
[3] J. E. Sadusk, Jr., F. G. Blake and A. Seymour, *Yale Jour. Biol. and Med.*, 12: 681, 1940.
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A FILTERABLE VIRUS DEMONSTRATED TO BE THE INFECTIVE AGENT IN OVINE BALANO-POSTHITIS[1]

SO-CALLED venereal infection of sheep has been recognized in some sheep-raising areas of the United States and other countries for over thirty years. It is known in this country as foul sheath, sheath infection, balanitis, venereal form of lip and leg ulceration and, in Australia, it is called pizzle-rot. Filmer, in Australia, proposed the terms posthitis and balanoposthitis. Lesions are most commonly found at the prepucial orifice and on the lips of the vulva, and in the male the penis may be involved. The disease is characterized by ulceration with scab production. The more severe lesions have been noted on the prepuce and vulva. Severe sheath lesions usually result in phimosis or paraphimosis. The penis lesion is ordinarily a mild inflammation with ulceration unless accompanied by paraphimosis, which then results in a severe process with the more extensive ulceration and heavy scab formation such as is found on the prepuce.

Until late years, the disease has been classified as one of the many necrophorus infections. In a previous examination of two naturally infected rams

[1] Paper No. 155, Journal Series, Agricultural Experiment Station, Montana State College.

presented at this laboratory, no necrophorus organisms could be found. In November, 1940, a number of ewes and rams affected with the venereal infection were made available for study. The ewes had ulcerative vulvitis and the rams had prepuce and penis lesions. In the majority of cases, the lesions were newly developed, presenting ideal material for bacteriological and virus examinations.

Aerobic and anaerobic cultures were made from the lesions of five naturally infected sheep, and six others that had been experimentally infected. Of this group of vulva, sheath and penis lesions, only the young or freshly formed ulcers were cultured. No anaerobes were recovered and none of the aerobic types were consistently present in all the lesions, with the exception of a very small Gram-negative bacillus. This organism was not pathogenic for guinea pigs or rabbits when injected intraperitoneally, and there was no evidence of an infection where pure cultures were swabbed into the scarified tissue of the vulva, prepuce or penis of experimental sheep.

Although experimental transmission of the disease was easily accomplished through the use of suspensions of the diseased tissue, a number of failures were experienced before an infective, bacteria-free filtrate was prepared. The technic by which the infective filtrates were obtained was as follows: The diseased tissue was finely ground with alundum, and then a suspension was prepared, using equal parts of beef broth (pH 8.2) and distilled water to which 5 per cent. horse serum was added. The suspension was clarified by high-speed centrifugation and the supernatant liquid was filtered. Successful filtrations were made with two virus suspensions of separate origin. The hydrogen ion concentration of the suspensions before filtration was pH 7.0 in one case and in another pH 8.2. Three infective filtrates were recovered from one suspension after passage through Berkefeld N & W candles and a 7 pound Mandler candle. The other suspension was filtered through a 3½ per cent. collodion membrane. Subcultures from these filtrates remained free of bacterial growth.

Typical lesions were produced on the prepuces of experimentally inoculated rams with each of these four filtrates. The disease was again transmitted to healthy experimental rams by prepuce inoculations with virus suspensions from two of the filtrate-produced cases. The experimental animals used in the tests and the premises on which the tests were conducted were free from infection before inoculation, as proven by uninoculated rams that were held as controls.

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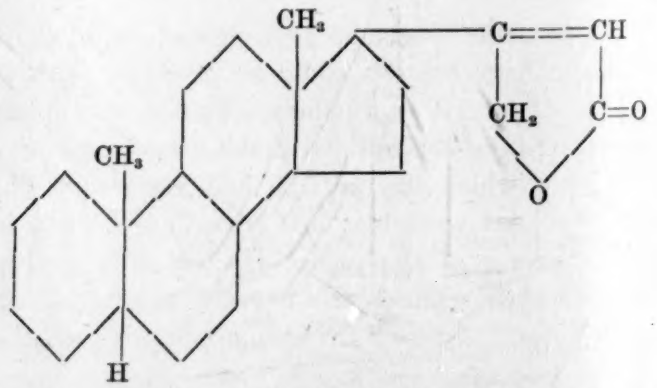
SYNTHESES OF MODEL UNSATURATED LACTONES RELATED TO THE CARDIAC AGLYCONES

SYNTHESES of β-substituted $\Delta^{\alpha,\beta}$-unsaturated γ-lactones related to the cardiac aglycones have been reported from different laboratories.[1,2] The substances described thus far represent with a high degree of certainty the lactone portion of the natural aglycones, having simple aliphatic, alicyclic and aromatic groups substituted for the cyclopentanophenanthrene part. Such compounds are not without value, and help to interpret reactions of the natural aglycones, which were difficult to explain previously. It was felt, however, that substances bearing a closer resemblance to those occurring in nature would be of interest for further study.

Of the syntheses published, that employing a carboxylic acid as starting material[3] appears to be particularly suited for the purpose in mind. From any etio acid, prepared by a Barbier-Wieland degradation of the corresponding bile acid, one proceeds to the desired lactone through the 21-acyloxy-methyl ketone, meanwhile protecting any alcoholic groups present. A similar series of reactions has recently been published by Ruzicka, Reichstein and Fuerst,[4] who converted 3,21-diacetoxy-$\Delta^{4,5}$-pregnenone-(20) into the lactone of 3,21-dihydroxy-$\Delta^{4,5;\ 20,22}$-norcholadienic acid.

We wish to report the synthesis of the lactone of 21-hydroxy-$\Delta^{20,22}$-norcholenic acid[1] in this brief note, leaving a detailed discussion for a later communication. This lactone, like digitoxigenin, thevetin and others, shows a *cis*-relationship of rings A and B as well as identical relative positions of the unsaturated lactone ring and the methyl group at C 13[5]. Etiocholanic acid through its acid chloride was converted into 21-diazo-pregnanone-(20), which with dry HCl in ether yielded 21-chloro-pregnanone-(20). This was reacted with sodium benzoate in 90 per cent. alcohol to give 21-benzoxy-pregnanone-(20), and the



1 Elderfield, *et al.*, *Jour. Org. Chem.*, 6: 260, 1941.
2 Ranganathan, *Current Sci.*, 9: 458, 1940.
3 Linville and Elderfield, *Jour. Org. Chem.*, 6: 270, 1941.
4 Ruzicka, Reichstein and Fuerst, *Helv.*, 24: 76, 1941.
5 Jacobs and Elderfield, *Jour. Biol. Chem.*, 108: 497, 1935.

latter subjected to a Reformatsky reaction with zinc and ethyl bromo-acetate, thus effecting condensation, partial dehydration and lactonization simultaneously. The lactone[1] melts at 167–168° (corr.) and reacts positively towards Legal's and Tollens' reagents. It shows the following analytical figures: Calculated for $C_{23}H_{34}O_2$: C, 80.6; H, 10.0. Found: C, 80.4; H, 10.1.

A detailed description of this and other lactones will appear in *The Journal of Organic Chemistry.*

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE MAGNETIC PROPERTIES OF CATALASE

RECENTLY a modification of Gouy's method of measuring magnetic susceptibilities has been elaborated in this laboratory primarily for the quantitative determination of free radicals of organic dyestuffs during the process of reduction. The result is an increased sensitivity over existing methods. The method will be described in a paper now in press and may be outlined very briefly as follows.

A long cylindrical vessel with a septum in the middle, dividing it into an upper and a lower compartment, quite similar to one first used by Freed and Casper,[1] and later especially by Pauling and Coryell,[2] is suspended between the pole pieces of an electromagnet. The upper end of the suspending wire is attached to the one pan of a semi-micro balance, which is magnetically damped, very nearly critically. The pointer of the balance is equipped with a scale of 200 divisions readable through a microscope, each line corresponding to about one hundredth of a milligram. The upper compartment of the vessel is filled with a solution, or suspension, of the substance to be measured. The lower compartment is filled with the pure solvent. After switching on the magnetizing current only the maximum deflection on the microscope scale is observed, which is reached in 15 seconds. The significance of each line of deflection is previously calibrated in terms of change in magnetic susceptibility. Repeated readings allow an accuracy, according to conditions, within one or a few per cent., even when the experiment is based on a magnetic pull of, say, one fifth of a milligram. This method has been used for the measurement of the susceptibility of crystallized catalase,[3] suspended in a dilute phosphate buffer. Thus far the measurements have been made under conditions not especially favorable for weighing, *i.e.*, warm and humid summer weather, and they may be worth repeating later on under better conditions. Even so, results could be obtained which were scarcely accessible to the method of direct weighing as used by Pauling and Coryell. Since catalase has four times the molecular weight of hemoglobin, yet not more iron in one molecule than the latter, and the concentration at which a suspension—not to speak of a solution—can be obtained, is limited, the increase in sensitivity over previous methods was essential for these experiments. The result obtained so far is that the magnetic moment of catalase, per gram-atom iron, is 4.64 Bohr magnetons. The probable error, under the unfavorable conditions mentioned, is estimated to be $\pm$ 0.3. This value would be close to 4.47 as obtained by Coryell and Pauling for ferri-hemoglobin hydroxide (alkaline methemoglobin), and smaller than for ferrohemoglobin (5.46) or ferri-hemoglobin (5.8). The magnetic experiments on catalase are being continued.

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[1] S. Freed and C. Casper. *Physical Rev.*, 36: 1002, 1930.
[2] L. Pauling and C. Coryell, *Proc. Nat. Acad. Sci.*, 22: 159 and 210, 1936.
[3] J. B. Sumner and A. L. Dounce, *Jour. Biol. Chem.*, 125: 33, 1938; 127: 439, 1939.

GLASS ELECTRODE FOR DETERMINATION OF HYDROGEN ION ACTIVITY OF SMALL QUANTITIES OF CULTURE MEDIA

INVESTIGATIONS of changes in pH in controlled cultures necessitate means of determining the pH of relatively small quantities of fluid. It was felt that a system whereby three determinations of pH could be made from as little as 1 ml of fluid would be very advantageous. After reviewing the possibilities of several micro vessels for this work, it was decided that a relatively large durable or condenser type of glass electrode, as described by MacInnes and Belcher,[1, 2] could be used, provided it was modified in some respects and a method developed for using the modified instrument. The results have been extremely satisfactory. The instrument is very stable and rugged. It is easily cleaned without being dismantled. Furthermore, the method of sampling and determination of pH precludes errors which might arise from addition or loss of gases such as CO_2.

A glass electrode is made (Fig. 1) with the following limitations and modifications:—The Corning No.

[1] D. A. MacInnes and D. Belcher, *Industrial and Engineering Chemistry*, Analytical Edition, 5: 199, 1933.
[2] D. A. MacInnes and L. G. Longworth, *Transactions of the Electrochemical Society*, 71: 73, 1937.

.015 glass capillary of the glass electrode should be of a length and inside bore to hold approximately 0.3 ml of fluid. The electrodes which we made averaged about four inches in length. The jacket of the electrode is extended to form a funnel 20 mm high and 25 mm across the top. The space at the bottom of the funnel is ground to accommodate a standard ground tip of a 1.0 ml hypodermic syringe. The hypodermic syringe is of the insulin type—long with a solid plunger, modified as follows: a 1 millimeter hole is drilled through the wall of the syringe, 2 mm above the last graduation and a short groove 2 mm long is cut in the lower end of the solid plunger.

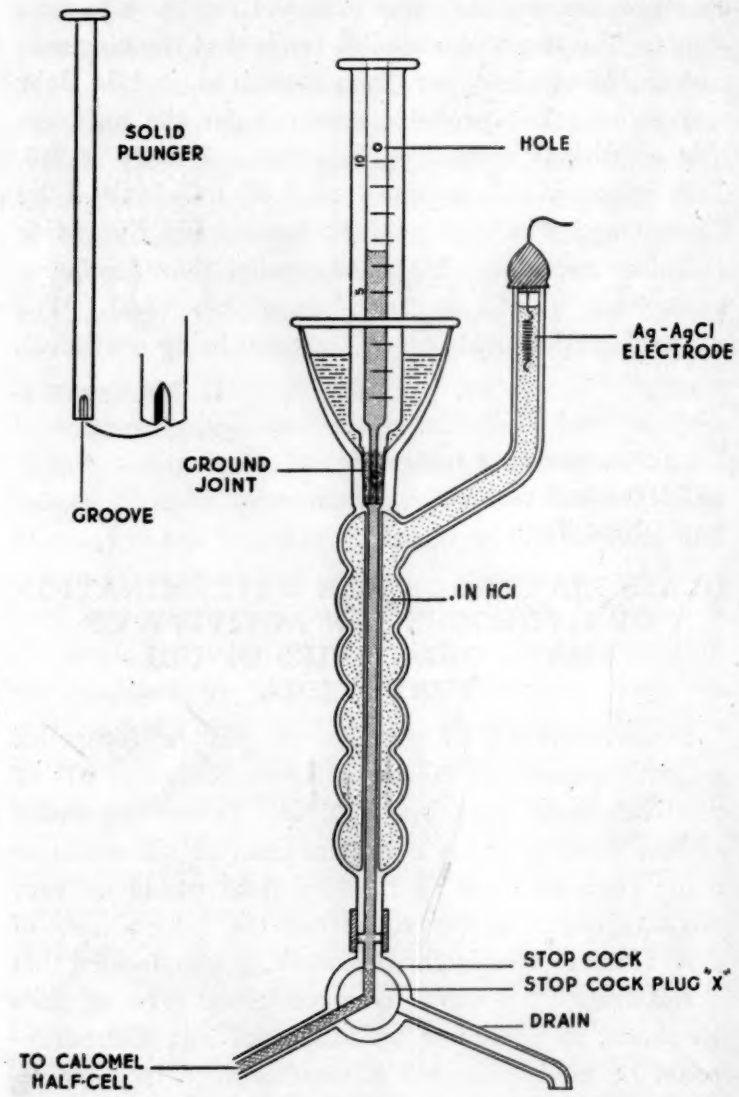

FIG. 1

METHOD OF OPERATION

The glass electrode is set up in an electrically shielded copper box connected by shielded cables to a type #7660 Leeds and Northrup Company pH indicator. After the glass electrode has been calibrated for acetate buffer pH 4.64 it is thoroughly washed out with distilled water. The stop-cock (Fig. 1, X) is then closed so that the distilled water fills the electrode and extends halfway up the funnel.

The material to be studied is introduced into the hypodermic syringe, care being taken to see that the groove in the solid plunger is oriented 180° from the hole in the syringe wall. In the case of pure cultures of protozoa the material is secured through a sterile needle introduced into a vaccine port blown in the side of the culture flask.[3] The needle is removed from the syringe and the syringe tip is introduced through the distilled water in the funnel and seated in the ground joint at the upper end of the glass electrode. This effectively seals off the distilled water in the funnel and places the culture medium in the syringe in direct contact with the column of distilled water in the glass electrode, without the possibility of any air bubbles being formed in the system. The plunger of the hypodermic syringe is now turned 180 degrees until the slot and the hole in the syringe coincide. The plunger may now be withdrawn without exerting pressure on the fluid. By carefully opening the stop-cock (Fig. 1, X) 0.3 ml of the culture medium is allowed to displace the distilled water in the electrode. The amount is determined by following the meniscus on the graduations of the syringe. The stop-cock (Fig. 1, X) is now turned to make a liquid junction and a determination is made. Two more determinations are made with the remaining available fluid. The syringe is then removed and the electrode again thoroughly washed with distilled water.

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